ADDITIONS TO THE FLORA OF THE SIERRA DE LA LAGUNA, BAJA CALIFORNIA SUR, MEXICO

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Abstract

The plant communities of the Sierra de La Laguna exhibit not only biological importance, but also socioeconomical importance to the peninsula of Baja California. This contribution is part of a project leading to establishment of an ecological preserve in such mountains. This work presents 48 additions to the flora of the woodland communities, 44 species are properly new additions, and 4 are reidentified taxa reported in a former paper. Most of the species (65%) are both annual and perennial herbs. An affinity geographical analysis of the total vascular plants of the woodland (272 species), shows that the community has high levels of affinity with the tropical flora at both family and genus level (39 and 37%, respectively), followed by the cosmopolitan flora (27 and 37%, respectively). The relatively high affinity with the cosmopolitan flora suggests a recent arrival of this flora in the woodland.

Resumen

Las comunidades vegetales de la Sierra de La Laguna presentan importancia no sólo biológica, sino también socioeconómica para la región sur de la península de Baja California. El presente trabajo forma parte de un proyecto más amplio que tiene como objetivo establecer una área para preservarse ecológicamente sobre tal serranía. Se presentan 48 adiciones a la flora del bosque de pino-encino y bosque de encino de la misma. Del total de adiciones, 4 son taxa reidentificados, y 44 son propiamente nuevos registros. La mayor parte de las especies (65%) corresponde a herbáceas. Un análisis de afinidad geográfica en el total de las especies vasculares de esta comunidad (272 especies) revela que se guardan relaciones estrechas con la flora de afinidad tropical tanto a nivel de familia como de género (39 y 37% respectivamente), seguida con la flora cosmopolita (27 y 37% respectivamente). La relativamente elevada participación florística cosmopolita sugiere un arribo reciente de esta flora.

The Sierra de La Laguna, located in Baja California Sur (the most arid state of all Mexico), has been considered an ecological island. Here, the lowlands consist of xeric vegetation, while the mountains and foothills harbor plant communities that are unique in all the peninsula of Baja California. A tropical deciduous forest is located in the foothills between 500 to 1000 m. In the mountains above 1000 m, woodland occupies an approximate surface of 300 to 350 km^2 and is composed of: a) an oak woodland between 1000 and 1500 m of elevation, dominated by the "roble" *Quercus tuberculata*; and b) the oak-pine woodland between 1500 and 2200 m, dominated by endemic species "pino piñonero" *Pinus cembroides* var. *lagunae,*

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"encino negro" *Quercus devia,* "madroño" *Arbutus peninsularis,* and "sotol" *Nolina beldinguii.* This classification follows Rzedowski (1978), in accordance with Mexican nomenclature.

This paper is concerned with the woodland community, which is important not only in a biological sense, but because no other area of the state receives similar rainfall. Both the vegetation and soil allow the rain water to recharge the local aquifers, providing water for urban and suburban populations, ranches, tourist developments, and small agricultural areas.

Continued research consisting of field trips, bibliographical reviews, and consultation with both authorities and herbariums (UC, RSA, CAS, SD, and MEXU) has resulted in the addition of 48 taxa for the vascular flora. Previous publications (León de la Luz and Domínguez Cadena 1989; Breedlove and León de la Luz 1989) yielded 228 species and infraspecific taxa. The earliest collector in the Sierra, T. S. Brandegee (1891, and subsequent additions) cited no more than 200 taxa for approximately the same area.

Increased human settlement in the vicinity has resulted in the destruction of this natural resource, and thus the woodland is at risk of losing its natural balance. The main purpose of this study was to support the establishment of an ecological protected area by documenting the flora as a natural resource that needs to be preserved.

Materials and Methods

Study area. The Sierra de la Laguna is the highest range in the southern mountains of Baja California Sur, Mexico, with the highest peaks reaching 2200 m. It is crossed by the Tropic of Cancer at 109°58′W. This Sierra is comprised of six major canyons. Soils are sandy in texture, with a thin layer of top soil with organic matter; it is formed from decomposition of late cretaceous granitic rocks.

Foothills and adjacent low areas have a warm and dry climate, but climate in the woodland is rather cool, with light frosts occurring on winter nights. Much of the rain normally occurs in summer, though winter rains are often the heaviest. Total annual amount of rain ranges between 500 to 900 mm. The dry season is from late winter to early summer.

Methodology. Eleven seasonal visits were made to several sites in the area between 1987 to 1991. Almost seven hundred voucher specimens were prepared and housed at Centro de Investigaciones Biológicas de Baja California Sur Herbarium (HCIB). Species determinations were made or checked by comparison with corresponding ejemplars stored at California Academy of Sciences (CAS), San Diego Museum of Natural History (SD), and University of California Berkeley (UC) Herbariums, and by consultation with the following authorities: Dennis E. Breedlove (CAS), Allan Smith & Annetta M.

TABLE 1. NUMERICAL SYNOPSIS OF THE SIERRA DE LA LAGUNA FLORA. Table does not include two undetermined species and excludes three species, two of which are probably extinct (one of them a monospecific genus), and one which does not correspond to the flora but was cited in the previous catalogue. Endemics = 43 (38 species and 5 infralevel).

Life form	Number of species
Trees	17
Shrubs and subshrubs	30
Annual and perennial herbs	176
Hydrophites	34
Climbing	5
Succulents	8
Saprophites and parasites	2

Carter (UC), Shirley Graham (KEN), Thomas Philbrick and Dave Thompson (RSA), Warren L. Wagner (Smithsonian Institution), and Geoffrey Levin (SD). Some additions have been taken from bibliographic references (Gould and Moran 1981; Wiggins 1980; Johnson 1958). Nomenclature follows mainly to Wiggins (1980).

RESULTS

Plants communities. Because of floral and structural differences between some sites, presumably due to sun exposition, availability of water, soil depth, and other factors, the oak-pine community has been divided in four associations named: "Valleys", "Stream Bottoms", "True Woodland", and "Open Areas" (León de la Luz and Domínguez Cadena 1989).

The area occupied by the oak woodland or "encinar" is very precipitous, with step surfaces ranging from 30° to 40°. The vegetation consists of scattered trees (*Quercus tuberculata*), low shrubs (*Dodonaea viscosa*), and both annual and perennial herbs; where grasses are the physiognomic dominants (*Muhlenbergia emersleyi*). At the same altitudes, a local riparian plant association occupies the bottom of the brooks and canyons. Streams descend along the canyons to 700–600 m above sea level. This association is characterized by *Populus brandegeei* var. *glabra, Salix lasiolepis,* and the fan palms *Erythea brandegeei,* and *Washingtonia robusta.*

The current flora. Forty eight species of vascular plants have been added to the first catalogue (León de la Luz and Domínguez Cadena, 1989); four of these were re-identified, and 44 are new recordings. Sixteen annotated species (16/48) do not have voucher specimens. Table 1 enumerates the current flora of the woodland according to life forms. There are 272 species in 184 genera representing 69 families. Two additional species (*Solanum* aff. *fendleri* and *Anoda* sp.) are awaiting adequate identification or description, and were

TABLE 2. DISTRIBUTION OF THE 272 SPECIES OF VASCULAR PLANTS WHICH FORM THE RECOGNIZED FLORA OF THE WOODLAND COMMUNITIES OF THE SIERRA DE LA LAGUNA.

	Families	Genera	Species and infra categories
Pteridophytes	4	14	19
Gymnosperms	1	1	1
Angiosperms	64	169	252
Total	69	184	272

not considered in the table. Table 2 shows the distribution of all the species according to their taxonomy.

Annotated catalog. The catalog is included in Appendix I. Each entry includes information on life forms (cf. Table 1), habitat, occurrence, flowering phenology, and common name. Endemic species are marked with an asterisk (*). The most common synonyms are also included.

Rare species. Some of the T. S. Brandegee's collections which he reported as "unique" or "few" have not been found again; these were *Faxonia pusilla, Pectis uniaristata* var. *uniaristata, Muhlenbergia wolfii* and *M. ciliata.* Specimens of *Ilex californica* are very scarce, only a dozen living trees are known. Other rare species, numbering less than 20 in restricted locations include: *Aralia scopulorum, Arenaria lanuginosa* subsp. *saxosa, Ilex brandegeana, Myrtillocactus cochal, Quercus arizonica, Q. oblongifolia, Q. reticulata, Styrax argenteus,* and *Morangaya* (*Echinocereus*) *pensilis.*

Excluded species. Eriogonum inflatum var. *deflatum* (Polygonaceae) is reported by Wiggins (1980) but has been not collected by the authors; none of the *Eriogonum* species occur further south than the Vizcaino Desert, thus Wiggin's citation should be considered an error for this area.

Oxalis corniculata (Oxalidaceae), *Oenothera laciniata* subsp. *pubescens* (Onagraceae), *Quercus oblongifolia* (Fagaceae), and *Sisyrinchium bellum* (Iridaceae) were mistakenly identified, and their true identity is noted in the appendix A.

Faxonia pusilla may be considered an extinct species. Its description was based on only one specimen collected during the late 19th century, and it has never been collected since. The location of the type label (UC) is given as "Sierra de La Laguna", but it is possible that the collection was obtained somewhere in the tropical deciduous forest. *Echinochloa cruspavonis,* cited by Gould and Moran (1981) and known in a few of the 19th century collections, has not been collected recently. According to T. Philbrick (1990, personal communication), there is no reason to include *Podostemon ceratophyl-*

TABLE 3. GEOGRAPHICAL AFFINITY OF FLORAL GROUPS OF FAMILIES AND GENERA OF THE VASCULAR FLORA OF SIERRA DE LA LAGUNA, AND THEIR NUMERIC CONTRIBUTION.

	Families Number (%)	Genera Number (%)
Tropical	28 (40.5)	109 (59.2)
Temperate	9 (13.1)	29 (15.7)
Cosmopolite	27 (39.2)	37 (20.1)
Disjointed	5 (7.2)	8 (4.4)
Endemic	0	1 (0.6)
Total	69	184

lum (Podostemonaceae) in this catalogue, our determination (cited in a previous work) was based on a sterile specimen of *Potamogeton.* The latter three species where not considered in our list.

Endemism. Before this work, a total of 228 species of vascular plants were reported for this region; thirty seven (37/228; 17%) species were considered endemic. The additions involve seven more endemic species. Two monospecific genera have been proposed as endemic, *Faxonia* (Compositae), and *Morangaya* (Cactaceae), but the former should be excluded because there is no evidence of its existence. Thus, the current number of endemic taxa is 43.

DISCUSSION

Some of the reports in the list of additions indicate range extensions of the correspondant taxa for the Sierra or the state. The incorporation of the additions did not modify the rate of endemisms; this remains at (43/272; 17%). The proportion of endemic species is moderate if compared to some of the closest natural areas such as Revillagigedo islands (32%), and Vizcaino Desert Biosphere Reserve (9%).

Table 3 shows the geographical affinity of the floral groups (families and genera) with the element tropical, temperate, cosmopolite (which includes worldwide, or pantropical), disjointed (some of the tropics, subtropics, or both tropic and temperate), and endemic. The corresponding family-genus with their geographical affinity was taken from Willis (1985). According to this same table, it is possible to observe that the tropical element is the most important at both the family and generic level, this result is not surprising because the Sierra always has been influenced by tropical climate since its geologic origin (Moore and Curray 1982). The temperate element only has moderate participation, the presence of these could be considered as remnants of the pleistocene flora, taxa of this category must be considered relictuals (Axelrod 1950, 1958).

Conclusions

The constant increase in the floral components in the Cape Region, where the Sierra is included, should not be attributed previous to incomplete field and identification work. It is possible that increasing human population and the trade traffic, has resulted in a continuous introduction of seeds over the last decades from mainland Mexico and several peninsular areas, many of them have achieved adapt to the conditions of this area and are now relatively common in landscape of certain communities (see Gilmartin and Neighbours 1978).

It has been said that the vegetation of the Cape Region has tropical features (Brandegee 1891; Shreve 1937; Wiggins 1960, and Rzedowski 1978); yet, the Sierra de la Laguna woodland does not appear to be distinct of this general pattern.

The relative low occurrence of endemisms in higher taxa (no families; and only two monospecific genera, one considered extinct and the other not well recognized), and moderate (17%) specific and infraspecific levels suggest that the isolation of the Sierra has not been effective. Rather, floristic incorporation from tropical and subtropical areas has resulted from a "continental bridge" with the west coast of mainland Mexico, or through certain areas of the Sonoran Desert. The authors are continuing to study the floristic composition of the Cape Region to answer the aforementioned questions.

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APPENDIX I.

ADDITIONS TO THE FLORA OF THE SIERRA DE LA LAGUNA

The additions, with an asterisk (*), are endemic taxa.

Polypodiaceae

—*Pellaea ovata* (Desv.) Weatherby. Oak forest, rare, perennial herb. Sep.
—*Thelypteris rudis* (Kuntze) Proctor. Oak forest, hydrophyte. Aug.–Sep.

Graminae

—*Andropogon glomeratus* Walt. B.S.P. oak pine and oak woodland, perennial herb. Sep.–Nov.
—*Eragrostis pilosa* (L.) Beauv. Oak woodland, annual herb. Sep.–Dec.
—*Eragrostis orcuttiana* Vasey. Oak-pine forest, annual herb. No voucher.
—*Hackelochloa granularis* (L.) Kuntze. Oak forest, annual herb. No voucher.
—*Muhlenbergia alamosae* Vasey. Oak forest, perennial herb. No voucher.
—*Panicum sonorum* Beal. A relative common grass in Baja California, sporadic in the oak woodland. Sep.–Nov.
—*Peyritschia pringlei* (Scribn.) Koch. Oak pine forest. This genus has been revised by Koch & Hernández (CHAPA), integrating it in *Trisetum.* Annual. Sep.–Nov.
—*Vulpia microstachys* (Nutt.) Benth. var. *pauciflora* (Beal) Lonard & Gould. Oak pine and oak forest. No voucher.

Cyperaceae

—*Carex longissima* M. E. Jones. Oak forest, perennial herb. No voucher.

Iridaceae

—*Sisyrinchium bellum* S. Wats. Rare along shaded arroyos, perennial herb. Mar.–May. This is the true identity to *S. demisum* Greene, cited in the previous work. Jan.–July.

—**Sisyrinchium translucens* (Bicknell) S. Wats. Locally abundant in both shaded and open areas in the oak pine forest, annual herb. Sep.–Jan.

Orchidaceae

—*Habenaria crassicornis* Lindley. Perennial herb from rootstock. Rare in the oak pine woodland. Sep.
—*Habenaria novembifida* Lindley. Perennial herb along currents, rare in shaded arroyos. May.

Amaranthaceae

—*Alternanthera repens* (L.) Kuntze. Occurring in gravelly soils in disturbed areas, an introduced weed from the tropical zone, perennial herb, flower almost all the year.

Begoniaceae

—**Begonia californica* Brandegee. Perennial but acaulescent herb, locally abundant in the oak woodland beneath rocks along currents. Sep.

Boraginaceae

—*Heliotropium fallax* I. M. Jhtn. Uncommon weed in the oak woodland, locally abundant in the lowlands. Sep.–Nov.?.

Compositae

—**Bidens amphicarpa* Sherff. Annual herb, locally abundant along streams banks and shaded slopes. Sep.–Oct.
—*Bidens lemmoni* A. Gray. Annual herb, locally abundant in disturbed soils in the oak woodland. Sep.–Oct.
—*Bidens leptocephala* Sherff var. *hammerlyae* Sherff. Annual herb, locally abundant beneath oaks. Sep.–Oct.
—*Bidens tenuisecta* A. Gray. Annual herb, uncommon in open spaces among oaks. Sep.–Oct.
—*Galinsoga semicalva* St. John & White var. *percalva* S. F. Blake. Annual herb, infrequent beneath trees in the oak pine and oak woodland, flowers after summer rains.
—*Heterosperma coreocarpoides* (Sherff) Sherff. Cited by B. H. Johnson (Op. cit.). Perennial herb in exposed areas, both oak pine and oak woodland. Aug.–Dec.
—*Pectis urceollata* Rydb. Annual herb, cited by I. L. Wiggins (1980, Flora of Baja California, Stanford University Press) at elevations corresponding the tropical deciduous forest and oak woodland. No voucher.
—*Stevia rhombifolia* H.B.K.. Infrequent shrub in the oak woodland, flower after rains.
—*Tagetes subulata* Cerv. Annual herb, locally abundant in exposed areas in the oak woodland. Sep.

Crassulaceae

—*Tillaea aquatica* L. Hydrophyte, inhabits in pools and another quiet body waters, rare, first register for the state. Mar.–Jun.

Euphorbiaceae

—**Euphorbia apicata* L. C. Wheeler. Oak pine and oak woodland, uncommon, annual herb. No voucher.
—*Euphorbia dentosa* I. M. Jhtn. Rare annual in the oak woodland and other exposed areas. Aug.–Oct.

Fagaceae

—*Quercus albocincta* Trel. Small populations of this tree are located sparingly in the woodland. Flowers appear presumably in late spring. This is the true identity to *Q. oblongifolia* Torr. cited in the previous work.

Gentianaceae

—*Centaurium capense* Broome. It is the true identity of *C. nudicaule* (Engelm.) Robinson, cited in the previous paper. Little annual in the open areas in oak and oak pine woodland. Mar.–Apr.

Labiatae

—*Salvia marci* Epling. A little population of this shrub was found growing in rocks in the highest elevations of the Sierra. Oct.–Dec.

Leguminosae

—**Clitoria monticola* Brandegee. Subshrub locally abundant in rocky and shaded slopes. Aug.–Sep.
—*Desmodium neo-mexicanum* A. Gray. Annual herb, locally abundant at the edges of valleys, common in lowlands. Sep.–Nov.
—*Lotus scoparius* (Nutt. ex T. & G.) var. *brevialatus* Ottley. Perennial herb, valleys, locally abundant, Jul.–Dec. [=*Hosackia glabra* (Vogel) Torr. var. *brevialatus* (Ottley) Abrams.]. Sep.–Jan.
—*Senna goldmanii* (Rose) Irwin & Barnaby. Oak woodland, uncommon in arroyos. Shrub. Apr.–Jun.
—*Senna polyantha* (Colladon) Irwin & Barnaby. Infrequent shrub in the oak woodland, proper in the lowland. Aug.–Sep.
—*Stylosanthes viscosa* Swartz. Oak pine and oak woodland, locally abundant, perennial herb. Sep.–Mar.

Lythraceae

—*Cuphea micropetala* H.B.K. Rare hydrophyte, inhabits in arroyos in the oak woodland; Feb.–Mar.

Onagraceae

—*Jussiaea suffruticosa* L. var. *octofila* (DC.) Munz. Annual herb cited by B. H. Johnson. Aug.–Oct. No voucher.
—**Oenothera breedlovei* W. Dietrich & W. L. Wagner. Perennial herb, locally abundant in open areas and valleys in the oak pine woodland. Flower almost all the year. It is the correct identity of *O. laciniata* Hill. subsp. *pubecens* (Willd.) Raven. [=*O. pubescens* Willd. ex Spreng.] cited in the previous work.

Oxalidaceae

—*Oxalis corniculata* L. Habits open areas in the oak pine woodland, perennial herb. It is *O. albicans* H.B.K. cited in the previous work. Flowers almost all the year.

Rubiaceae

—*Houstonia asperuloides* (Bentham) A. Gray. Annual herb, locally abundant in sandy and exposed areas, relatively common at lowlands. Sep.–Feb.

Scrophulariaceae

—*Buchnera pusilla* H.B.K. Distributional record for this scarse and delicate saprophyte, known from tropical areas of mainland Mexico. Oct.
—*Galvezia juncea* (Benth.) Ball var. *pubecens* (Brandegee) I. M. Jhtn. Shrub growing in rock crevices, oak pine woodland. Sept.–Feb.
—*Mecardonia exilis* (Brandegee) Pennell. Hydrophyte, rare along arroyos, it is a species proper of the foothills of the range. Mar.–Apr.
—*Mimulus dentilobus* Rob. & Fernald. Hydrophyte, cited as uncommon along permanent streams in the oak pine woodland (Wiggins 1980). No voucher.

Thymelaeaceae

—**Daphnopsis lagunae* Breedlove & León de la Luz. Shrub, locally abundant in open areas in both oak and oak pine woodland. Aug.